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THESIS

AN ANALYSIS OF THE VARIABLES IN THE DECISION
TO REVERT FROM A DUAL SOURCE TO SOLE
SOURCE ACQUISITION METHOD

by

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December 1990

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An Analysis of the Variables in the Decision to Revert
from a Dual Source to Sole Source Acquisition Method

by

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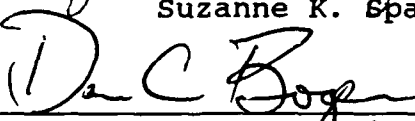
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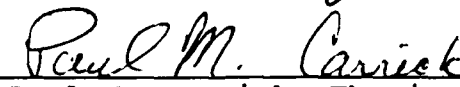
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ABSTRACT

This thesis examines the various methods the Navy has used to develop and foster competition. It also discusses the economic analysis of using more than one source of supply. Rising costs and budgetary pressures have forced the Navy to reexamine its acquisition process. With the impending force draw down, the Program Manager is faced with reduced quantity requirements. Since the enactment of the Competition in Contracting Act in 1984, the Navy has required the use of dual sources in major weapons systems. However, this method of acquisition may no longer be economically feasible. Faced with reduced requirements and limited resources, the Program Manager must reevaluate the costs and benefits of his acquisition method.

This thesis examines the economic issues the Program Manager must consider when reconsidering the dual source acquisition method and presents a decision model to assist in evaluating which programs would yield an economic benefit by down selecting to one source of supply.



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I. INTRODUCTION

A. PURPOSE OF THE RESEARCH

Under the present climate of shrinking budgets, reduction of forces, and the resultant reduction in material requirements, the Department of Defense (DoD) finds itself having to reexamine its acquisition methods to ensure all requirements can be met at a reasonable cost to taxpayers.

During the 1980's the use of dual source competition was required in major systems acquisition wherever possible. Dual source competition required a second source of supply, whether pre-existing or purposely generated to fulfill this role. Creating or convincing a vendor who is not already established or producing to become a second source of supply for a program can be both costly and difficult. Often a considerable amount of investment by the Government is required initially in order to introduce an additional source of supply to establish dual competition in weapons acquisition.

Rising costs and budgetary pressures are unlikely to allow procurement in the 1990's at the rate the Services have projected. Therefore, in the coming years there might not be sufficient quantities required to support and justify the continued use of more than one contractor. For this reason the Navy is investigating programs to determine whether

reducing the number of suppliers to a single source will result in cost reductions.

Although the 1984 Competition in Contracting Act mandated the legal obligation to incorporate competition into defense acquisition, budget constraints have necessitated reevaluation of the use of dual sources as a means of competition and as a method of increasing benefits to the Government.

The purpose of this thesis is to examine the economic logic used by the Program Manager to support the decision to buy a reduced requirement from a single source of supply. The emphasis will be on programs already in production.

B. RESEARCH QUESTIONS

The following specific question will be addressed during this study.

1. Primary Research Question

What will be the impact on production cost, given the decision to revert to a single source from a dual source acquisition method, and how might these costs be minimized?

2. Subsidiary Research Questions

- What are the essential differences between the key production costs when going from dual sources to a single source?
- What action should the Government and contractor take to minimize production costs?
- Can a model be developed to determine which programs are no longer candidates for dual source acquisition?
- What can be expected in pricing during buy-out?

C. RESEARCH METHODOLOGY

The informational research methodology employed in this study consisted of the following methods:

- Literature search was used to identify and obtain information on the policy and legislation which initially directed competition in general and dual source methods in particular.
- Interviews with cost analysts, contracting personnel, and representatives from the Office of the Competition Advocate General were conducted to discuss the rationale for selecting and the effects of dual source methods of competition.

D. ORGANIZATION OF THE STUDY

A brief overview of the requirement to use competitive procedures and of the methods available to foster competition, emphasizing the process of dual source competition, will be presented in Chapter II.

Chapter III will provide an analysis of the literature review and interviews concerning the present economic decision making process.

Chapter IV will propose a decision model to be applied in the current DoD scenario when making the decision to revert to a sole source contracting method.

Finally, Chapter V presents the conclusions and recommendations of the author. Included are answers to the primary and subsidiary research questions and suggestions for further research.

II. BACKGROUND

A. INTRODUCTION

In recent years competition has become the norm in major systems acquisition. With the growing pressures from the Administration, Congress, and the general public to reduce spending, DoD decision makers are under a mandate to use scarce resources wisely. Competition is considered a useful tool in constraining cost increases.

Competition, as conducted within DoD, requires that at least two qualified suppliers of a product or service be willing to provide it at prices which are determined by bidding. Bidding will presumably result in a lower cost because suppliers will increase their efficiency and may decrease their profit margins in order to successfully compete. A lower price is not always the only consideration in competitive procurement; quality and industrial base concerns may also influence procurement decisions. [Ref. 1:p. 5-2] However, primarily because of the widely held belief that competition can significantly reduce the cost of acquiring major weapon systems, the requirement to compete has been made law.

The primary focus of this thesis is on dual sourcing as a method of procurement and the methods used to determine its benefits. Dual sourcing, for the purpose of this thesis, is

defined as a procurement technique wherein two or more sources respond to a Government solicitation representing a total requirement which will be split among the two sources. The larger share will normally go to the lower priced supplier and a smaller share or a minimum sustaining rate is guaranteed to the higher priced producer.

This chapter will present a brief overview of the history of how dual sourcing came to be as prominent as it is today. A discussion of the various methods of dual source acquisition will also be presented.

B. HISTORICAL PERSPECTIVE

Over the years, politicians and defense procurement critics have agreed that the degree of competition in the production phase of the acquisition programs could be increased by expanding the use of the dual-source procurement technique. The common belief was that by maintaining at least two sources of supply throughout this phase, the benefits of competition, specifically that of lower contract prices, would result. These beliefs culminated with the passage of the Competition in Contracting Act.

Public Law 98-369, the Competition in Contracting Act (CICA), became effective in April of 1985. Prior to CICA, dual sourcing was primarily used when technical, delivery, or cost problems with the sole source contractor necessitated the development of an alternate source of supply. CICA provided

statutory authority for establishing a second source based on expected cost reduction, mobilization, or the need to maintain an essential experimental, research, or developmental capability. [Ref. 2:p. 2]

Also during 1985, Public Law 99-145, the 1985 DoD Authorization Act, provided that in developing acquisition strategies for systems and major sub-systems, competitive alternative sources would be utilized throughout the period from the beginning of full scale development (FSD) through the end of production.

CICA provided waivers to the requirement to use alternative sources during FSD if the Secretary determined their use inappropriate for any of the following reasons:

- Where use of alternate sources would not reduce technological risk.
- Where the additional cost of developing an alternate source would not result in a commensurate improvement in design.
- Where use of an alternate source would unduly delay fulfilling DoD's requirement.
- Where national security would be adversely affected.

During production, the use of an alternate source may only be waived when the Secretary determines that its use would:

- Increase total program costs.
- Cause unacceptable delays in delivering the product to DoD.
- Be adverse to national security.

Even prior to the enactment of the above legislation, Public Law 98-212, the DoD Appropriations Act of 1984, required a plan for the development of two or more sources for production of any system or subsystem funded by the Act. Only upon certification that the system or subsystem being developed was being procured in quantities insufficient to justify development of two or more production sources could the requirement for competition be waived. This requirement has been included in each succeeding year's appropriation act. SECNAVINST 4210.6A, "Acquisition Policy," dated 13 April 1988 includes these requirements as part of the Navy's policy on the use of dual sources.

Through directives and instruction, the DoD provides the program manager with additional guidance concerning competition. DoD Directive 5000.1 presents competition as one of the primary acquisition management principles. DoD Instruction 5000.2 places heavy emphasis on review of the program's acquisition strategy, including both design and price competition at major milestones.

C. TECHNIQUES USED IN COMPETITIVE PRODUCTION

While the focus of this thesis is upon dual source decisions concerning programs well along in the FSD phase or already into production, it is important to note that competition is required at all stages of the acquisition

process. During the Concept Exploration/Definition phase, there may be competitive research and development contracts awarded to develop concepts in parallel.

Competitive exploration of alternative systems allows the Government to take full advantage of industry's innovative talents and enables the evaluation of risks early in the acquisition cycle. [Ref. 3:p. 8] The most promising concepts are chosen for further exploration. In recent years, the Government has relied upon the use of critical component prototyping as early as the Concept Validation phase. This concept leads to a reduction of the technical uncertainties accompanying the various concepts and enhances verification "that the chosen concepts are sound, perform in an operational environment, and provide a basis for selection of the system design concept to be developed into Full Scale Development (FSD)." [Ref. 4:p. 16]

During FSD, competition continues with the solicitation of the requirement to develop and document a system which is both affordable and capable of satisfying the mission need. During this phase, independent test and evaluation is conducted by the Government through the requirement to use competitive prototypes in shoot-offs, fly-offs, and sail-offs to demonstrate capability. At the conclusion of this phase the decision whether to proceed into production is made.

Since this thesis is primarily concerned with the decision to change the acquisition method during the production phase,

a discussion of the five most common methods of generating alternate sources during that phase will follow. This section will address those methods and their major advantages and disadvantages. The five methods to be described are: form-fit-function (F^3), technical data package, directed licensing, leader-follower, and contractor teams.

1. Form-Fit-Function (F^3)

This method does not require the use of a technical data package (TDP) nor interaction between production sources. Alternate sources are provided with functional specifications regarding parameters such as overall performance, size, weight, and external configuration, among others. This is the classic "black box" concept where internal design commonality is not required. It is useful for the acquisition of expendable, non-repairable items where the ability of the system to perform as required is not dependent on what is inside the "box."

The primary advantage to this method is that it offers an easy means to solicit competition. Additionally, because there is no technical data package, the Government need not spend time and effort in validation. Finally, because each contractor is free to pursue any method of meeting the requirement, innovation often results in a lower overall unit cost because the contractor designs the system based upon its existing manufacturing processes.

One of the major disadvantages of this method occurs when the product requires logistics support. If the internal configuration of the item produced by competing sources is radically different, spares and test equipment may present a problem in the field. However, this can be minimized by the careful selection of systems/products to be procured by this method. [Ref. 5:p. 54]

2. Technical Data Package

A stand alone technical data package is used to generate alternate sources to produce an item. A Level III technical data package will normally be obtained under the original development or production contract. According to SECNAVINST 4210.9 of 25 January 1988, a Level III package consists of the complete set of engineering drawings and instructions which fully describe characteristics of each component part, subassembly and end item, as well as detailed physical and performance characteristics, quality assurance provisions, materials to be used, and manufacturing processes to be followed.

The major advantage of using the technical data package technique lies in the fact that once the Government has validated the technical data package, it can be used repeatedly to foster and maintain competition. Additionally, with a good technical data package, the technical, schedule and cost risks involved with technology transfer are minimized.

However, the validation of the technical data package represents a drawback to this method of competition. The process of validation can be a costly and time consuming effort and once the Government has validated the package, it assumes responsibility for its accuracy. Additionally, the acquisition of technical data can be a costly process if the Government has not funded or only partially funded the development effort. [Ref. 6:p. 31] Finally, a major problem can arise should the developing contractor declare a critical component to be proprietary and refuse to provide technical data.

The TDP approach has been successfully used to develop a second source in the AN/AYK-14 Standard Airborne Computer. The Navy acquired data rights from Control Data Corporation (CDC) in its original development contract. The Naval Avionics Center (NAC) validated the data using the build to print method to fabricate the end item. After NAC worked out data problems directly with CDC, a second source was solicited. Sperry, chosen as the second source, performed another data verification while building their "learning" quantity. By using NAC for guidance and technical support, Sperry never had to deal directly with CDC.

With the exception of a proprietary memory module, for which Sperry had to develop an alternate design, the AN/AYK-14 is being produced by both contractors from the same TDP.

Spares and components from each contractor are fully interchangeable. [Ref. 7:p. 36]

3. Directed Licensing

The licensing technique of establishing competitive production sources is used when the original source has patented all or selected processes or systems. A contractual agreement exists allowing the Government to conduct competition for production quantities, select a winner and appoint him as a licensee. The developer or licensor will provide technical assistance and manufacturing data to the licensee in exchange for royalties or fees. The system developer retains rights to proprietary data and maintains system responsibility.

The main advantages of licensing are minimization of the Government burden associated with technology transfer, the introduction of competition early in the process and the utilization of the developing contractor's unique capabilities. The main disadvantages are the cost of motivating the developer to enter into a licensing arrangement and the potential for adversarial relationships between the licensor and licensee. [Ref. 8:p. 2-13]

4. Leader-Follower.

The leader-follower technique achieves technical transfer through the direct technical assistance from the system developer (leader) to the second source (follower). This technique is generally used when the second source would

be unable to produce without the developer's assistance. Assistance involves training, technical assistance, material support, vendor qualification, and detailed manufacturing support to the second source.

The leader-follower technique is achieved in one of three ways:

- The Government awards a prime contract to the producer with a requirement to subcontract for a designated portion of production to a specified follower and to provide assistance to the follower in production of the required end items.
- The Government awards a prime contract to the leader to provide assistance to the follower who also has a prime contract with the Government for production.
- The Government awards a prime contract to the follower with the requirement for it to subcontract to the leader for technical assistance. [Ref. 7:p. 40]

Methods one and two are most frequently employed.

The advantages of the leader-follower technique include the minimization of the burden of technology transfer, enhanced use of the leader's capabilities, and some reduction in redundant hardware/software/firmware developments through "lessons learned" communicated by the leader to the follower.

The primary disadvantages include the cost to motivate or give incentive to the leader to participate, the potential for adversarial relationships between the leader and follower, and finally the managerial burden upon the Government to oversee the process. [Ref. 8:p. 2-9]

5. Contractor Teaming

Contractor teaming is the preferred method of establishing competitive production sources as delineated in SECNAVINST 4210.6A which states,

The development cycle of each program will begin with a minimum of two contractors/contractor teams performing concurrent, but separate development up to FSED at which time it will normally be narrowed to two contractors developing a system to one design. [Ref. 10:p. A-7]

This method involves formation of a team of two or more contractors for the full scale development of a system. Each team member designs and fabricates specific subsystems and components of the system, with each ultimately sharing design and manufacturing data with each other. The end result is two or more qualified production sources for the complete system. This technique may be accomplished through the award of a prime contract to one of the team members with a requirement to subcontract with the other team member, or by the contractors entering into a joint venture arrangement and the subsequent award of a prime contract to that joint venture.

The primary benefit of the teaming technique lies in the fact that contractors are encouraged to be innovative during the design phase, and this may result in identification of two or more qualified production sources early in production. The primary disadvantages to this technique occur when the contractor teams engage in "finger pointing" when difficulties occur, or when one team member is in a stronger

position and takes advantage of the weaker member. [Ref. 7:p. 40]

Of the five methods described above, F³ and directed licensing are more suited to full and open competition. TDP, leader-follower and contractor teams are the primary methods of dual source contracting. While the program manager has various methods available to develop second sources, there are basic issues to be addressed prior to any decision to pursue this method. In a recent memorandum for Secretaries of the Military Departments, the Under Secretary for Acquisition posed the following issues to be addressed when analyzing the use of competitive alternative sources for production.

- 1) Number of systems planned to be procured along with the production rate profile, the potential minimum and maximum quantities, and an estimate of the break-even point for recovering dual-sourcing investments.
- 2) Identification of the assumptions made in performing the cost-benefit analysis, including experience curve projections and behavior during sole-source and dual-source conditions, and adjustments made for changes in production rate.
- 3) The Government and contractor nonrecurring costs associated with tooling and test equipment.
- 4) The cost of educational buys and qualification testing, including the added costs resulting from smaller buys from the prime contractor during the learning and qualification periods of the second source.
- 5) Method to be used in implementing the necessary technology transfer, whether it be by data package, leader-follower arrangement, or form, fit, and function. Depending on the method to be used for the technology transfer, the implications of any proprietary data or logistics impacts will be included in the analysis.

6) Planned methods for maintaining configuration management.

7) A discussion of the supplier base capable of producing the system to include whether there is any requirement to develop different vendors from the current prime's vendors.

8) Currently budgeted funds compared to funding required to implement the dual-sourcing arrangement. Total program budgets should be included.

9) A discussion of the impact of alternative sources on program schedule. [Ref. 10:Attachment A]

D. SUMMARY

This chapter has discussed the major methods of generating alternative sources for production. The next chapter will discuss the various elements and methods used in the analysis of costs or benefits of dual sourcing.

III. COST ESTIMATING AND COMPETITION MODELS

A. INTRODUCTION

Because the DoD policy is based upon a belief that competition creates cost savings, any discussion of the effects of competition usually includes a statement that competition has reduced costs by a certain amount. In order to arrive at that amount, it is necessary to have an estimate of costs under different selling structures and production rates, as well as a model to analyze the effects of competition. This chapter will discuss the most commonly used methods of cost estimating and the models frequently used by DoD to project and analyze the effect of competition.

In the process of estimating costs for production, the analyst must use historical data on "what systems did cost, combine the theory and understanding of why the elements of cost emerged with programmatic and technical variables of the new system, and forecast what the new systems will cost." [Ref. 12:p. 3]

While there are a number of cost estimation and analysis techniques, the key element in all of them is that the data must be complete, accurate and relevant, and the analyst must know which data truly affect the analysis and which should be discarded. The next section will briefly describe the three

generic cost estimating/analysis techniques known as bottom-up engineering, analogy, and parametric methods.

B. COST ESTIMATING METHODS

1. Bottom-up Engineering Estimates

Bottom-up engineering estimates are based upon detailed system specifications, drawings, and industrial standards and require the estimation of costs from the lowest level of work effort. The total cost is then estimated by summing up all individual elements in the effort being analyzed. These estimates are sensitive to design and manufacturing changes and must be adjusted to reflect integration costs, overhead, and administrative expenses. Because this method is sensitive to design and manufacturing processes and changes, it is well suited to identifying cost driving elements. This method is best suited to well-defined efforts because of its reliance on requirements for detailed information. [Ref. 8:p. 4-11]

2. Analogy Estimates

Cost estimates by analogy are based upon relationships to costs experienced for similar items (e.g., the ratio of hardware to engineering costs based on ratios experienced in similar programs). Current cost information on similar systems or processes should be adjusted to reflect differences between the systems or programs. The accuracy depends upon the similarity to historical programs, as well as the adequacy

of any adjustments. Because this method relies on comparisons to other programs and usually cannot assess cost drivers, it is not as useful in assessing the effects of program or design changes. [Ref. 8:p. 4-9]

3. Parametric Estimates

Parametric estimates use actual historical costs to project relationships between cost elements and system or process characteristics. Parameters such as size, weight, or performance characteristics are used in estimating costs. These statistically derived estimates are commonly called cost estimating relationships (CERs). They are sensitive to design and program changes and can identify cost drivers. While they are less accurate than engineering estimates, they are often used when the system is less well-defined. [Ref. 1:p. 4-11]

The product, the amount of detail required, and the data available will affect the choice of cost estimation method. For example, contractors do not have access to the cost history that DoD possesses (e.g., other contractor's data). Thus, they rely more heavily on the bottom-up method. On the other hand, DoD has little in-house capacity to use, or check the use of, the engineering method and tends to rely upon the parametric and analogy methods.

C. COST ELEMENTS

The costs that must be analyzed in the dual source scenario are normally classified into nonrecurring and recurring.

1. Nonrecurring Costs

Nonrecurring costs represent those costs incurred to bring the second source on board as a viable competitor. They may include special tooling and test equipment, facilities cost, technical transfer, the costs of qualifying the second source (e.g., testing and qualification of the qualification buy), as well as contractor and Government management costs. [Ref. 8:p. 2-13]

2. Recurring Cost

Recurring cost variables are defined by the Navy Competition Handbook as "all cost elements that are subject to dual sourcing such as prime mission equipment, warranties, engineering change orders, and engineering services." Additionally, it lists the following as key recurring variables:

- Initial source first unit cost, cost improvement rate and production rate factor.
- Second source first unit cost, cost improvement rate and production rate factor
- Initial source price changes due to dual sourcing, including changes in cost improvement. [Ref. 7:p. B-1]

Analysis of the decision to develop a second source is extremely difficult because the analyst must make a projection

of costs for a hypothetical contractor for comparison to an existing producer. Only in contractor teaming or leader-follower might the analyst have insight into both of the participant's anticipated behavior.

Another difficult task for an analyst is to predict the rate and change of the progress curve. The progress curve is defined as "including all recurring costs, amortized capital, overhead and profit" as opposed to the learning curve which "implies reductions in labor hours due to worker learning." [Ref. 8:p. 4-9] Many factors influence the slope of learning curves. Changes in production rate, tooling, capital equipment, product design and management strategy may influence the slope; however, their individual effects are lost when lumped together in a progress curve. [Ref. 13:p. 28]

Both the progress curve and learning curve provide a method of estimating unit costs or production time of future units based upon the first unit and an assumption that the contractor will become more efficient the longer he produces. Because both are based upon the first unit, if the hours or costs for this unit have not been controlled and are artificially high, projections for subsequent units will be inflated.

Any model evaluating the effects of competition will require comparison of the historical nonrecurring cost to establish competition, initial sole source recurring costs, an

estimate of the sole source cost for the completed quantity, and estimates of both the original producer and second source costs under competitive conditions. [Ref. 7:p. B-1]

D. ECONOMIC ANALYSIS OF THE EFFECTS OF COMPETITION

This section discusses the areas that must be addressed in the analysis of the introduction of dual source competition into a previously sole source program. Although there are several models commonly used to estimate costs and evaluate the effects of competition, they all basically apply the following generic steps:

- Step 1: Estimate the investment and production cost of the sole source supplier through the remainder of the program.
- Step 2: Estimate the investment requirement to establish the dual source production capability.
- Step 3: Estimate the cost of production by the original source operating in a dual source, competitive environment.
- Step 4: Estimate the cost of production by the second source.
- Step 5: Compare the result of Step 1 (sole source) with the sum of the results Steps 2, 3, and 4 (dual source). The least costly alternative is selected. [Ref. 7:pp. B-16]

An analysis of projected program costs should ensure that total program savings are sufficient to pay for:

- Nonrecurring facilitization costs.
- Shortened production runs.
- Lowered production rates.

- Duplicative qualification buys.
- Educational buys.
- Technology transfer costs.
- Configuration management.
- Duplicative program management costs. [Ref. 8:p. 2-13]

In general, the economic variables that should be considered in any cost benefit analysis include the total quantity required, planned duration of production, progress or price improvement curve, tooling and test equipment costs (nonrecurring costs), the recurring costs of production, and contractor capacity. Because several years may elapse between the time nonrecurring costs are made and the point at which the contractor can successfully compete, adjustments should be considered for the time value of money.

All of the models used by the Navy to estimate and analyze the effects of competition generally refer to and apply a downward shift and rotation (steepening) of the progress or price improvement curve (PIC) once production competition is introduced. This change in the PIC, known as the "shift and rotation" was first introduced in 1979 in "Predicting the Costs and Benefits of Competitive Production Sources," a report prepared by The Analytic Sciences Corporation (TASC). [Ref. 14:p. 22] This theory was based on the assumption that downward shifts and rotations would occur because the sole source producer was capable of, but had no incentive to, reduce his costs (or profit) prior to the introduction of

competition. Only when the threat of competition was introduced, would he immediately reduce his price to compete and correct his inefficient processes which would result in a steeper PIC slope.

Figure 1 is an example showing the effect of competition on the sole source's curve both before and after introduction of competition. It also projects the second source's expected behavior. [Ref. 7:p. B-11]

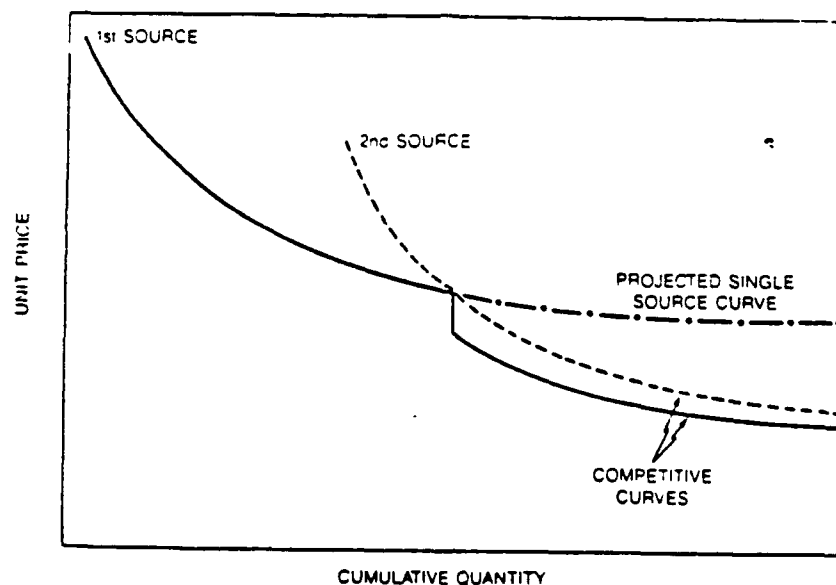


Figure 1. Shift and Rotation Effect

This "shift and rotation" effect has been criticized by Dr. Michael N. Beltramo for its assumption that,

...the initial source has knowingly incorporated inefficiencies into its production process and/or is making excess profits;...that virtually any second source can (and will) achieve the same level of efficiency as the initial source and that competitive prices set by both contractors will be based upon their costs with a similar, but small profit included. [Ref. 14:p. 6]

In evaluating the first competitive lot of ten dual source programs, he noted a downward shift with an upward rotation in five of the ten cases he studied. This would result in the sole source's competitive learning curve eventually crossing over its own sole source curve at some point. [Ref. 7:p. B-16]

A Center for Naval Analysis (CNA) study of models used to estimate the effects of competition also criticized the "shift and rotation" effect as "too narrowly based" and suggested that any economic model analyzing defense procurement must consider "the institutional, technical and behavioral characteristics of the defense procurement process." [Ref. 12:p. 3]

The Defense System Management Handbook for Program Managers attempts to warn program managers to recognize the danger of simply assuming the same "shift and rotation" for all programs by discussing the following circumstances which could affect the magnitude of the potential shift and rotation:

- Intensity of the competition. If the original producer perceives that the second source cannot be competitive, perhaps due to inadequate technology transfer, the original producer is less likely to offer price reductions.

- Timing of the competition. If the competition is held early in the production cycle when production risks still remain, the original producer will be less willing to offer large price reductions.
- Ability of the original producer to reduce costs. If the system was competitively developed and the original producer has demonstrated adequate cost control, the contractor may not be capable of further price reductions. Conversely, if the original developer has experienced significant cost growth, competition may lead to greater control and large cost reductions.
- System and manufacturing technology. If the manufacture of the system requires complex processes and equipment, the original producer may be unable to offer large price reductions. [Ref. 8:p. 4-15]

While the circumstances above still would lead the program manager to believe that the sole source contractor is operating in an inefficient manner, at least it represents an attempt to encourage the program manager to question the rate of the shift and rotation effect.

Any economic analysis must include sensitivity analysis not only of the progress curve and shift and rotation effect but also of the total planned quantity and production rate, as well as the timing of the competition. During an interview with this author, Bruce Parker, an analyst in the Naval Sea Systems Command Cost Analysis group (SEA-017), indicated that in addition to sensitivity analysis in those areas, he also considered other factors. Not only does he consider the technology, timing of the competition, and total planned quantities when looking at the rate of shift and rotation, he also tries to evaluate the company's position in its industry

(in general) and its business base (in particular) to try to more accurately predict their pricing behavior. [Ref.16]

He also indicated that in the past he has been asked to evaluate programs using inflated production quantities rather than what was actually planned for, which in effect, skewed the results in favor of initiating dual source competition. He was unaware of whether any decisions to conduct dual source competition had been based solely on his analyses. An example of where a decision was actually made to proceed with an alternate source based on an inflated production projection is the case of the TOW missile. According to a recent article,

In the case of TOW, Hughes aircraft was required to facilitate a capability to manufacture up to 30,000 a year. The missile was then second-sourced, although the actual budgets funded only 13,000-14,000 systems. Facilities for a second source cost over \$100 million, but that contractor (Raytheon) produced only two missiles before acquisition goals changed, and production was terminated in a winner-take-all competition, won by Hughes. [Ref. 18:p. 42]

The methods available to the analyst/program manager facilitate the prediction and comparison of the difference between the unit cost which the sole source contractor would experience both with and without competition to the projected unit cost of the second source. In evaluating the sole source price, the analyst must also consider the pricing behavior of the sole source producer. Greer and Liao have hypothesized three alternative strategies a firm may pursue in response to competition:

- Constant percentage profit--price is a constant mark-up over cost.

- Penetration (limit) pricing--if the Government has not committed to competition, the firm sets a price that is low enough to discourage the introduction of competition.
- Skimming pricing--if the Government is committed to competition, the firm sets a high price and lowers it as necessary. [Ref. 19:p. 41]

Additionally, they have examined industry utilization as a strategic consideration for contractors. According to their study, during periods of high utilization, contractors are unlikely to offer lower prices and conversely, during lean periods, contractors will often offer substantially lower prices to continue to work or stay in business. [Ref. 19:p. 41]

Beltramo has frequently cited the Stackleburg duopoly model as a possible consideration when analyzing dual source competition. The duopoly theory in split buy scenarios implies two types of firms exist. The first firm may choose to be the leader and through aggressive strategies in price or quality pursue a dominant position in the market. Alternatively, the other firm may have no desire to be dominant and will adopt the follower strategy and accept a smaller percentage of the total requirement at the higher (less competitive, price. Effective competition can only occur when both contractors are willing and able to pursue an aggressive pricing strategy. [Ref. 13:p. 8]

Another important consideration in the economic analysis of dual source competition is the question of the minimum sustaining rate (MSR). This is the minimum quantity that must

be awarded to the contractor with the higher/less competitive price. There is no foolproof way to verify the contractor's estimate of his MSR and since the Government has guaranteed award of that amount contractors are prone to inflating their bids for that quantity. [Ref. 20:p. 16]

E. SUMMARY

The economic analysis of costs and benefits of any decision relating to a change in acquisition strategy will require a comparison of actual costs under current conditions projected into the future, with an estimate of the future costs given the change in the acquisition methodology. Various models exist to allow an analyst to "plug and chug" numbers to come up with a savings/loss. However, if the institutional, technical and behavioral characteristics of the process are not considered, the result may be flawed. Consequently, the arithmetic is probably the easy part; the answers to the economic questions that arise out of the analysis are far more difficult to obtain and, in the long run, are probably more important than the actual numbers produced by the models.

The next chapter will present and discuss a decision model to be used to help evaluate the decision to conduct a winner-take-all competition for the remaining requirement, given the reduction in requirements resulting from the reduction of forces and budget cuts.

IV. A DECISION MODEL TO CONTINUE/DISCONTINUE DUAL SOURCING

A. INTRODUCTION

Chapter III concluded that the simplified economic models used by Navy program managers lend themselves to a fairly easy mathematical solution to predict and estimate the effects of competition. However, they fail to account for the strategic behavior of contractors or to predict the real net effect of the decision to pursue competitive production. Only by further analysis of the purpose, acquisition method, price improvement curve, pricing strategy practiced by the sole source producer, total requirement, and planned production rate can the program manager make a sound business decision to proceed with the use of dual competition.

Faced with a reduced requirement and severely limited resources to fund it, the program manager is challenged with the problem of reevaluating costs and benefits of the program. The models presently available lend themselves to working the problem "backwards" to try to analyze the effect of a one time competitive buy-out. Given that two sources are qualified and co-producing, the variables in the equation should be fairly easy to determine. However, just as in making an analysis of whether or not to pursue a dual source strategy, the Government analyst must have a thorough understanding of the

contractors' estimating methodologies, pricing strategies, and cost information.

In working "backward" to try to predict the effects of buying-out the remaining (reduced) requirements, one must once again analyze the effects on nonrecurring and recurring costs, as well as the contractors' expected pricing behavior. If the hardware is a mature product, both producers will probably have demonstrated and priced along a learning curve already familiar to the Government. Therefore, the program manager should have a fairly valid starting point upon which to analyze the unit price in competition.

If both contractors have the tooling and capacity to produce the remaining quantity, then the Government will probably experience minimal nonrecurring costs associated with the decision to down select to one source. However, if neither is capable of producing an increased quantity during the buy-out, the Government must weigh the costs of additional tooling and production equipment against the projected savings from a buy-out.

The cost of retooling the winner to increase his production capacity may be offset by reduced unit cost due to a higher production rate. Theoretically, an increased production rate will result in a lower cost because of the redistribution of indirect charges; overhead costs (e.g., depreciation of plant equipments and toolings, insurance, utilities, etc.) are spread over larger quantities.

Additionally, higher quantities may make it possible for the contractor to take advantage of quantity discounts on parts or materials. [Ref. 21:p. 20]

The flip side of the production rate question is the effect upon the losing contractor in a buy-out scenario. While the Government will "save" the expense of the loser's indirect costs; if the losing contractor has other Government business, those charges may simply shift to the other programs. Consequently, while the program manager might experience some benefit in only paying indirect charges for one contractor vice two, the fixed cost portion of that savings may end up as a ripple effect that increases costs for other DoD programs!

Depending on the contractual arrangement the losing contractor has with the Government, the program manager must consider those costs associated with terminating the existing contract. These costs can be quite substantial and must be thoroughly evaluated. However, termination might present the opportunity for the Government to procure the losing contractor's tooling to be provided to the winner in order to increase his capacity.

Finally, the recurring costs must be evaluated. However, since the Navy has awarded most of the dual source contracts using firm fixed price contracts and based the contract prices on the fact that there was adequate price competition, actual

historical cost data (as opposed to price) may not be readily available.

While costs appear to be easily defined and categorized as recurring or nonrecurring, in reality, they are often ill defined and highly aggregated. For example, direct labor and direct material are immediately associated with production and therefore, could be easily classified as a recurring cost. However, a significant amount of both direct labor and material are often used to qualify a second source and should be classified as nonrecurring when used for this purpose. This ambiguity in classifying costs often makes the "after the fact" computation of savings difficult unless detailed data are available. For instance, if the nonrecurring material and labor costs charged by the second source to build the initial qualification units are accumulated and reported as production costs, the program manager may erroneously conclude that the second source unit cost is much higher than the sole source unit cost. Table 1 illustrates some of the more important cost elements and how they can be classified.

The decision to down select to a single source of supply should involve a detailed cost-benefit analysis. In addition to the analysis, application of the decision model depicted in Figure 2 will give the program manager another tool to use when making the decision to continue the split buy or down select to a single source.

TABLE 1
RECURRING/NONRECURRING COSTS

FUNCTIONAL COST	RECURRING	NONRECURRING
TOOLING	X	X
FACILITIES		X
DATA	X	X
TECH. TRANSFER		X
MAINTENANCE	X	
PERSONNEL	X	X
PROGRAM MANAGEMENT	X	X
TESTING		
QUALIFICATION		X
INTERFACE	X	
VERIFICATION		X
OVERHEAD	X	X
DIRECT MATERIAL	X	X

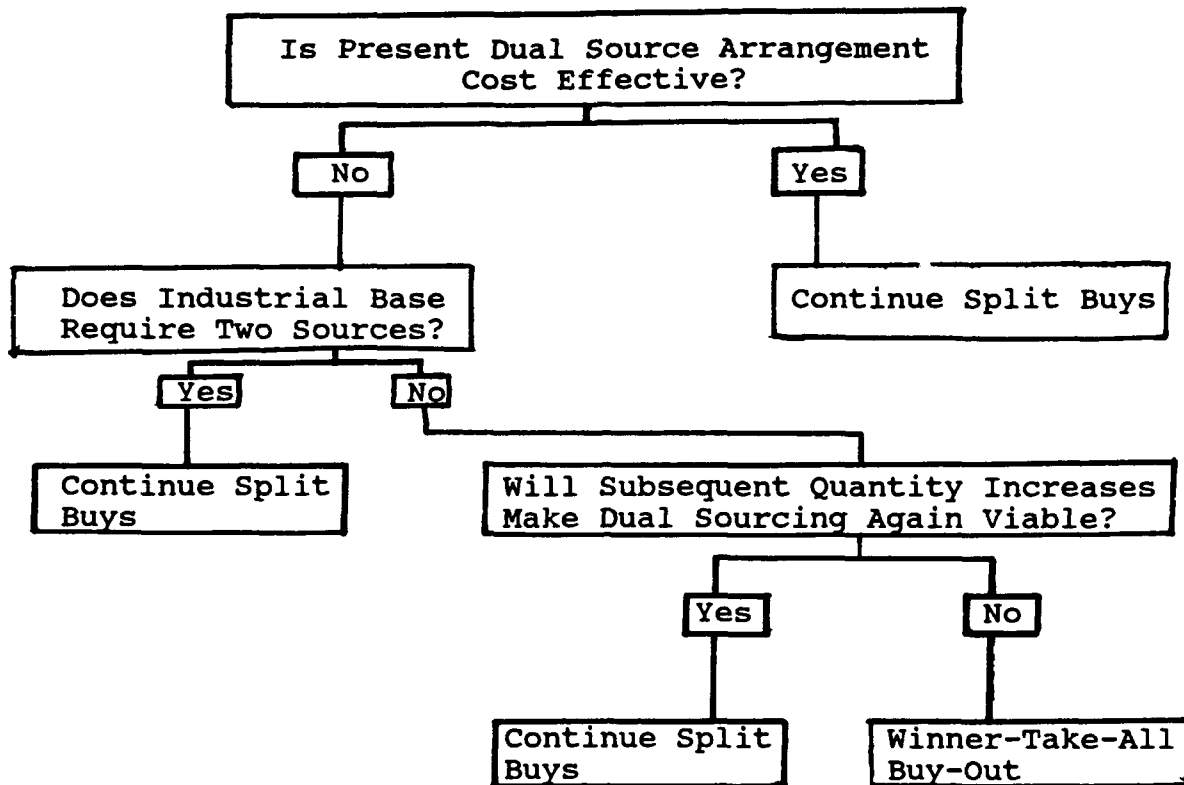


Figure 2. A Proposed Decision Model

B. THE MODEL

1. Is the Proposed Dual Source Arrangement Cost Effective?

The answer to this question requires a look back to the initial decision to dual source and whether its savings have paid for the nonrecurring investment costs. This is easier said than done. A frequent criticism of the dual source methodology is the failure to monitor and record investment costs. A standard approach must be adopted to measure all programs by the same yardstick. The approach must

be tailored to specific program characteristics (e.g., electronic programs, missiles and missile components, or shipbuilding) and must include all pertinent investment costs. The argument could be made that these costs are "sunk costs"; however, to evaluate the net savings or loss, they must be considered.

In evaluating cost effectiveness, one must also look at why costs have come down. Have the contractors invested in new facilities or innovative techniques that have contributed to lower costs? Have aggressively-controlled overhead costs contributed to the savings? Has quality and reliability improved?

The Phalanx Close In Weapon System program highlighted an important side effect of dual source competition. In response to a Program Budget Decision (PBD) which directed a competitive buy-out of several programs, ASN conducted a study of the Phalanx program. The study predicted that in addition to foregoing between \$55-160 million in projected savings, the decision to down select would result in "significant engineering impacts" because of both contractors heavy involvement in on going support and development efforts. [Ref. 22:p. 2] The level of shared responsibilities between the contractors can often be an important consideration.

Finally, is either source tooled for the buy-out quantities? If not, the facilitization cost would have to be weighed against the potential savings from production of

higher quantities. If the answers to all, or the majority, of the above questions are yes, and if the quantitative cost-benefit analysis indicates that down selecting to a single source of supply will result in a cost increase, it would be best to continue with the split buy. However, if there appears to be no future benefit to continued split buys, the program manager must consider the next question.

2. Does the Industrial Base Require Two Suppliers?

If the initial dual source acquisition strategy was solely to enhance the defense industrial base, the program manager must redetermine whether Government intervention in the form of directed buys are still necessary. Are economic conditions, foreign competition or insufficient production capacity still critical issues impacting the ability to surge or mobilize in the event of emergency? The program manager may have to conduct a market survey to determine whether other sources of supply will be available should the decision be made to no longer maintain a contractor through a directed dual source. If the circumstances still warrant continued support of the industrial base, then the decision to continue to split buys would be appropriate. If the industrial base no longer requires extraordinary support, the program manager must consider the next question.

3. Will Subsequent Increases in Quantities Make Dual Source Again Viable?

The program manager should consider future needs, foreign military sales, spares, training units, and system variants when considering this issue. Both Navy and other Service programs should be reviewed with the objective of combining requirements. If both contractors have the capacity and tooling for the higher buy-out quantities and increased production rate, the program manager should consider the probability of increased requirements in the future. If it appears that spares, FMS, or joint Service requirements will present competitive opportunities in the future, the program manager should continue with split buys. If not, a one time winner-take-all competition should be conducted to award the remaining requirements.

Once the decision has been made to buy the remaining requirement in a winner-take-all competition, the Government must attempt to minimize its costs. Just as a downward shift and rotation is often assumed, and may have occurred with the introduction of competition, the Government must take measures to minimize the winner's potential to exercise classic sole source pricing behavior and introduce a deleterious shift and rotation effect.

Because the quantity requirement, item configuration, and funding at the point of buy-out will probably be stable, and the program manager will probably have a high degree of

confidence in both contractors' ability to perform, the multiyear procurement (MYP) approach may present an opportunity to reduce costs. The Acquisition Strategy Guide defines MYP as:

...a method of acquiring more than one year's but not more than five years' requirements under one contract. Each program year is budgeted and funded annually, but the commitment is for at least several years. [Ref. 1:p. 5-39]

MYP is implemented through a multiyear contract which binds the contractual parties to a longer and more stable relationship. The FAR defines a multiyear contract as "a contract covering more than 1-year's but not in excess of 5-years' requirements...funds need only to have been appropriated for the first year." [Ref. 9:17.101]

In multiyear contracts, demand is fixed at the time of contract formation, allowing for more accurate production and material requirements forecasting. Therefore, because it provides a longer Government commitment to the contractor, MYP may result in savings from improved economies and efficiencies in the production process, economies-of-scale lot buying, decreased financial borrowing, better utilization of industrial facilities, and a reduction in the administrative burden to both the contractor and Government.

However, the potential for savings only exists if both competitors are willing and able to pursue an aggressive pricing strategy. Additionally, while a multiyear contract commits the Government to a contract extending beyond one

year, funds are still made available by Congress on an annual basis. Should Congress fail to fund the remainder of a multiyear contract, the Government is still liable for certain costs associated with the contractor's "upfront" incurrence of material or facilitization costs in his efforts to achieve outyear economies.

While multiyear contracting offers the potential for savings and cost containment, its use must be approved by Congress. Over the years, Congress has enacted restrictive legislation associated with multiyear contracting. One of the main reasons Congress has been reluctant to approve MYP programs may lie in its reluctance to forfeit control over major programs. Once designated multiyear, a program cannot be modified or canceled without incurring substantial penalties. However, if properly monitored, multiyear contracting can offer a win-win proposition to both the Government and the contractor. The Government can realize the benefits of competition; and through the use of a fixed price contract, the contractor has incentive to control his costs and maximize his profit.

Another method of controlling costs is by the use of a fixed price contract with options. This method of contracting does not offer the same type of opportunity for cost savings as multiyear. This method seems to favor the Government, in that, even though the contract is awarded with a base year and options, the Government is legally required to

test the market prior to exercising the options and may turn to another source of supply. Therefore, the contractor loses some of his flexibility to price strategically because he must make his pricing decision at the point of the competitive buy-out, with no guarantee of future business. The use of a base year with option years protects the Government in the event the requirements change. However, because the contractor has no guarantee that the options will be exercised, he has no incentive to take on the risk of ordering material in economic quantities in the base year to minimize the costs of the outyear requirements.

Another tool the Government could employ to discourage the winner in a buy out situation from taking advantage of a sole source position could be to pay the loser to maintain his tooling. The major drawback to this alternative lies in the problem associated with estimating the cost of storing or relocating production equipment, tooling and fixtures. Additionally, unless the contractor is a multiproduct firm, the costs to lay-off and subsequently rehire could be prohibitive. However, if this alternative were possible, with the tooling available, the loser might still pose a competitive threat should circumstances change. Another alternative available to the Government would be to simply purchase as much of the tooling as possible to be used as GFE should the need arise.

As previously stated, in many cases the Government has not always had access to detailed cost and pricing data or historical costs. The lack of data severely restricts the Government's ability to estimate the effects of a change in acquisition strategy. Regardless of the method the Government uses to acquire the remaining requirements, cost data must be obtained. The visibility of cost and pricing data during the buy-out coupled with visibility of actual costs as they are incurred will enable the program manager to limit the winning contractor's ability to introduce a price-increasing shift of the PIC. The requirement to provide the cost data will probably increase the cost of the buy-out; however, it may be a small price to pay to provide the program manager with a valuable tool to control costs if properly used.

C. SUMMARY

This chapter has discussed the questions and issues which the program manager must address when making the decision to down select to one source of supply given the scenario of significantly reduced requirements. The decision model is an additional tool to be used to look at some of the more subjective questions associated with such a decision. Finally, several recommendations are offered as a method of protecting the Government's position given a return to a single source of supply.

V. SUMMARY AND ANSWERS TO RESEARCH QUESTIONS

A. SUMMARY

This thesis has examined the rationale for using a dual source acquisition method, and has described the various means of accomplishing technical transfer and identified the economic issues the program manager must consider when evaluating dual sources. The major reasons Navy policy has emphasized dual source competition as an acquisition method are ensuring quality, obtaining a lower price and protecting the industrial base.

The most common methods of achieving technology transfer and generating second sources are the following:

- Fit-form-function (F³).
- Technical data package.
- Directed licensing.
- Leader-follower.
- Contractor teams.

These techniques vary in their complexity and cost in accomplishing the transfer of technical information from the Government and between contractors.

While the program manager has various methods he/she might use to develop alternate sources, an indepth cost/benefit and economic analysis must be made prior to the decision to use

dual sources as an acquisition method. The questions and issues that must be addressed are summarized as follows:

- The decision must be based on a realistic requirement and production rate profile.
- Any cost/benefit analysis will include examination of the experience curve projections and discussion of the expected behavior during sole-source and dual source conditions, as well as sensitivity analysis of varying production rates.
- Analysis of the nonrecurring costs of tooling and test equipment.
- The cost of educational buys and qualification testing. The additional costs resulting from smaller buys from the prime contractor during the learning and second source qualification period.
- A market analysis of the vendors capable of producing the desired system.

The program manager has various methods available to analyze his/her decision. These methods range from informal back-of-the-envelope calculations to software developed specifically for this purpose. However, any conclusion must be based upon and include an understanding and analysis of cost estimating methods, cost elements, pricing behavior, derivation of the experience curve, and the effect of any shift or rotation as well as the variables driving the movement of the experience curve.

In short, while the analyst can come up with variables to use in cost/benefit models, the answer the model provides is only as good as the information upon which it is based. The models can perform calculations; however, the answers to the

economic questions that come from the analysis really add substance to any decision process.

Ironically, when faced with the requirement to analyze the effects of reduced quantities and to decide whether or not to down select to one source of supply, the analysis requires the same basic intuition and calculations necessary in making the decision to pursue dual sources. The program manager must consider the pricing strategy, effect on the experience curve, effects on recurring and nonrecurring costs and quantity/production rates.

In conclusion, the program manager must understand the variables he/she is using to compute a bottom line figure when doing a cost/benefit analysis. He/she must consider the timing of entering into or backing away from competition; the intensity of the competition between the sources; the ability of the producers to further reduce costs or in the case of a buy-out, maintain the same PIC; and finally, the state of the technology and other business base issues.

B. RESEARCH QUESTIONS ANSWERED

The primary and subsidiary research questions are restated below.

- What will be the impact on production cost, given the decision to revert to a single source from a dual source acquisition method, and how might these be minimized?
- What are the essential differences between the key production costs when going from dual sources to a single source?

- What action should the Government and contractor take to minimize production costs?
- Can a model be developed to determine which programs are no longer candidates for dual source acquisition?
- What can be expected in pricing during buy-out?

The first two questions are intertwined and cannot be answered definitively as the effects will vary with each specific program. However, since a buy-out will normally result in a higher production rate for the winner, the production costs may be affected in two ways. First, additional nonrecurring costs might be necessary if neither contractor is tooled for the buy-out quantities. However, the object of the analysis is to ensure these additional costs are offset by savings due to a lower unit cost realized when the fixed costs are spread over the winner's higher production rate. An additional source of savings which might be realized with an increased production rate stems from the winning contractor's ability to get quantity discounts from his suppliers for parts or materials.

If the winner must be retooled for higher quantities and hire more production workers, he might experience a negative rotation in his experience curve that could result in a higher unit cost. Also, should the buy-out quantity result in a lower rate of production, the Government may be exposed to the costs of laying off workers and the cost of dismantling, moving or storing production equipment.

Additionally, in a buy-out scenario, since the Government is no longer paying the indirect costs for two sources, the loser's indirect costs can be considered "saved." However, these costs ultimately may be reflected in other Government programs as they are redistributed over the contractor's remaining business base.

The program manager has several means to minimize the effects on production costs. The most important tool is his/her understanding of the contractors' behavior at the point when competition was introduced, as well as their subsequent behavior throughout the period of competition. By understanding the contractors' estimating methods, pricing strategies and motivation for continued government business, the program manager can more accurately estimate the contractors' behavior when faced with a winner-take-all buy-out.

Since the program manager should have some visibility of the historical costs under competition, he/she may have a basis for each contractor's experience curve; and therefore, a baseline to establish cost control measures for the winner of the buy-out. The use of either a multiyear contract or a base year contract with priced options will give the program manager some leverage in holding down the contractor's cost during buy-out. The cost to the Government will only be minimized by contract type if both contractors are willing to

pursue an aggressive pricing strategy during head to head competition.

The multiyear method seems to offer the most potential for both the Government and the contractor to minimize costs. By providing a longer Government commitment to the contractor, it may allow him to realize savings from improved economies and efficiencies in the production process, economy of scale lot buying, better utilization of facilities and personnel and a possible reduction in the administrative burden to the Government.

The use of the base year with option method offers a less attractive means of controlling costs. If the contractor is bidding aggressively it forces him to commit to "showing his hand" during buy-out, and yet reserves the right to the Government of recompeting the option years. Thus, the threat of competition remains over the winning contractor's head. Another method of continuing the threat of competition is by paying the losing contractor to maintain his tooling, or buying the tooling to be provided as GFE, should the need to reintroduce competition arise.

A final method, and in this researcher's opinion, the most important tool in controlling costs, is to acquire cost and pricing data during the buy-out and require the winning contractor to provide actual cost data during the period of performance. While this requirement may result in higher program costs for data, it will be money well spent should the

need to recompete arise. The more visibility the program manager has into the contractor's costs, the more power he/she has to contain those costs.

No economic model exists to determine candidates to be down selected to one source of supply given a sudden reduction in requirements. This researcher was unable to obtain data on programs which would provide sufficient detail to develop a meaningful quantitative model. The current methodology can be applied to help the program manager quantify his/her decision, and a simple decision model is provided to highlight some of the more subjective areas the program manager must also consider in any decision to change the program acquisition strategy.

In conclusion, any decision will require a cost/benefit analysis to try to quantify the effects of any change. However, any projected cost/saving must be based upon a thorough analysis of all variables considered. Additionally, good business judgment dictates that the program manager consider other issues such as contractor motivation, business/industrial base considerations, and future political considerations when making his/her decision.

C. AREAS FOR FURTHER RESEARCH

- Study the actual buy-out behavior in specific programs under the conditions of a reduced requirement.
- Study contractors' behavior during dual source acquisition. Did they become more efficient by

modernization and advanced technology, or did they take less profit?

- Study the ripple effect of indirect costs on other Government programs.

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